ME211 Key Equations For The Exam (Midterm 1 and 2) :

$$n = m/M$$

$$T(^\circ\mathrm{C}) = T(\mathrm{K}) - 273.15$$

$$\Delta E = \Delta U + \Delta \mathrm{KE} + \Delta \mathrm{PE}$$

$$\Delta \mathrm{KE} = \mathrm{KE}_2 - \mathrm{KE}_1 = \frac{1}{2}m(\mathrm{V}_2^2 - \mathrm{V}_1^2)$$

$$\Delta \mathrm{PE} = \mathrm{PE}_2 - \mathrm{PE}_1 = mg(z_2 - z_1)$$

$$W = \int_{s_1}^{s_2} \mathbf{F} \cdot d\mathbf{s}$$

$$\dot{W} = \mathbf{F} \cdot \mathbf{V}$$

$$W = \int_{V_1}^{V_2} p\, dV$$

$$E_2 - E_1 = U_2 - U_1 + m\left[\tfrac{1}{2}({V_2}^2 - {V_1}^2) + g(z_2 - z_1)\right]$$

$$E_2 - E_1 = Q - W$$

$$\frac{dE}{dt} = \dot{Q} - \dot{W}$$

$$W_b = \frac{P_2V_2 - P_1V_1}{1-n}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\left(\frac{n-1}{n}\right)}$$

$$W_{\text{cycle}} = Q_{\text{in}} - Q_{\text{out}}$$

$$\eta = \frac{W_{\text{cycle}}}{Q_{\text{in}}}$$

$$W_{\text{cycle}} = Q_{\text{out}} - Q_{\text{in}}$$

$$\beta = \frac{Q_{\text{in}}}{W_{\text{cycle}}}$$

$$\gamma = \frac{Q_{\text{out}}}{W_{\text{cycle}}}$$

1 liter =10^{-3} m^3
1 atm =101.325 kPa
1 bar =100 kPa

$$x = \frac{m_{\text{vapor}}}{m_{\text{liquid}} + m_{\text{vapor}}}$$

$$v = (1-x)v_f + xv_g = v_f + x(v_g - v_f)$$
$$u = (1-x)u_f + xu_g = u_f + x(u_g - u_f)$$
$$h = (1-x)h_f + xh_g = h_f + x(h_g - h_f)$$

$$v(T,p) \approx v_f(T)$$
$$u(T,p) \approx u_f(T)$$
$$h(T,p) \approx h_f(T)$$

$$pv = RT$$
$$u = u(T)$$
$$h = h(T) = u(T) + RT$$

$$u(T_2) - u(T_1) = \int_{T_1}^{T_2} c_v(T)\, dT$$

$$u(T_2) - u(T_1) = c_v(T_2 - T_1)$$

$$h(T_2) - h(T_1) = \int_{T_1}^{T_2} c_p(T)\, dT$$

$$h(T_2) - h(T_1) = c_p(T_2 - T_1)$$

$$PV = mRT$$

$$R = \frac{\bar{R}}{M}$$

$$\bar{R} = 8.314\ kJ/kmolK$$

$$k = \frac{c_p}{c_v}$$

$$\dot{m} = \frac{\mathrm{AV}}{v}$$

$$\frac{dm_{\text{cv}}}{dt} = \sum_i \dot{m}_i - \sum_e \dot{m}_e$$

$$\sum_i \dot{m}_i \quad = \quad \sum_e \dot{m}_e$$

(mass rate in) (mass rate out)

$$\frac{dE_{\text{cv}}}{dt} = \dot{Q}_{\text{cv}} - \dot{W}_{\text{cv}} + \sum_i \dot{m}_i\left(h_i + \frac{\mathrm{V}_i^2}{2} + gz_i\right) - \sum_e \dot{m}_e\left(h_e + \frac{\mathrm{V}_e^2}{2} + gz_e\right)$$

$$0 = \dot{Q}_{\text{cv}} - \dot{W}_{\text{cv}} + \sum_i \dot{m}_i\left(h_i + \frac{\mathrm{V}_i^2}{2} + gz_i\right) - \sum_e \dot{m}_e\left(h_e + \frac{\mathrm{V}_e^2}{2} + gz_e\right)$$

$$0 = \dot{Q}_{\text{cv}} - \dot{W}_{\text{cv}} + \dot{m}\left[(h_1 - h_2) + \frac{(\mathrm{V}_1^2 - \mathrm{V}_2^2)}{2} + g(z_1 - z_2)\right]$$

$$0 = \frac{\dot{Q}_{\text{cv}}}{\dot{m}} - \frac{\dot{W}_{\text{cv}}}{\dot{m}} + (h_1 - h_2) + \frac{(\mathrm{V}_1^2 - \mathrm{V}_2^2)}{2} + g(z_1 - z_2)$$

$$\eta_{\max} = 1 - \frac{T_{\mathrm{C}}}{T_{\mathrm{H}}} \qquad \beta_{\max} = \frac{T_{\mathrm{C}}}{T_{\mathrm{H}} - T_{\mathrm{C}}} \qquad \gamma_{\max} = \frac{T_{\mathrm{H}}}{T_{\mathrm{H}} - T_{\mathrm{C}}} \qquad \oint\left(\frac{\delta Q}{T}\right)_{\mathrm{b}} = -\sigma_{\text{cycle}}$$